CLINICAL SCIENCE

# The Brazilian Football Association (CBF) model for epidemiological studies on professional soccer player injuries

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**OBJECTIVE:** This study aims to establish a national methodological model for epidemiological studies on professional soccer player injuries and to describe the numerous relevant studies previously published on this topic.

**INTRODUCTION:** The risk of injury in professional soccer is high. However, previous studies of injury risk in Brazil and other countries have been characterized by large variations in study design and data collection methods as well as definitions of injury, standardized diagnostic criteria, and recovery times.

**METHODS:** A system developed by the Union of European Football for epidemiological studies on professional soccer players is being used as a starting point to create a methodological model for the Brazilian Football Association. To describe the existing studies on professional soccer player injuries, we developed a search strategy to identify relevant epidemiological studies. We included the Latin American and Caribbean Center on Health Sciences and Medline databases in our study.

**RESULTS:** We considered 60 studies from Medline and 16 studies from the Latin American and Caribbean Center on Health Sciences in the final analysis. Twelve studies were selected for final inclusion in this review: seven from the Latin American and Caribbean Center on Health Sciences and five from Medline. We identified a lack of uniformity in the study design, data collection methods, injury definitions, standardized diagnostic criteria, and the definition of recovery time. Based on the information contained within these articles, we developed a model for epidemiological studies for the Brazilian Football Association.

**CONCLUSIONS:** There is no uniform model for epidemiological studies of professional soccer injuries. Here, we propose a novel model to be applied for epidemiological studies of professional soccer player injuries in Brazil and throughout the world.

**KEYWORDS:** Soccer; Football; Athletic Injuries; Epidemiology; Epidemiologic Studies.

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## INTRODUCTION

Soccer is undoubtedly the most popular sport in the world with 200,000 professional athletes and 240 million amateur players globally; approximately 80% of these players are male.[1,2] Studies have shown that soccer players have a 1000-fold higher risk of injury than industrial workers.[3]

As a sport, soccer has undergone many changes in recent years, mainly due to increased physical demands. This has led to increased injury risk. In Brazil, athletes are more prone to injury because of their extensive training and the large number of games they play.[4] The incidence of soccer injuries is estimated to be approximately 10-15 injuries/1000 hours of practice. However, this statistic varies widely among studies depending on the injury definitions used and each study's design.[5]

Several groups of researchers around the world have initiated research aimed at assessing the incidence and causes of soccer injuries. Currently, the goal is to reduce injury incidence and increase athlete safety. However, to achieve this goal, we must develop a thorough knowledge of the epidemiology of soccer injuries. Only then can we identify the problems that lead to soccer injuries.[6]

A major problem with the epidemiological assessment of soccer injuries is the inconsistency observed between studies. For example, injury definitions and methods for data collection and recording are often quite different between



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studies. As a result, epidemiological studies in Brazil and other countries are characterized by a lack of uniformity in study design, data collection methods, injury definitions, standardized diagnostic criteria, and recovery time.

To accurately interpret the results from epidemiological studies on professional soccer player injuries, findings from different studies must be compared. However, methodological differences in the various scientific studies have made meaningful comparisons impossible. Therefore, a uniform methodological model is needed to conduct epidemiological studies on professional soccer player injuries.

This study aims to establish a methodological model for epidemiological studies on professional soccer player injuries and to describe the numerous previously published studies on this topic. Creating and establishing this model is very important because Brazil is quite different from European and other countries with respect to football and geography.

## MATERIALS AND METHODS

This research project was approved by the Ethics Committee of Universidade Federal de São Paulo/Escola Paulista de Medicina.

To perform a meta-analysis of the existing studies on professional soccer player injuries, we developed an extensive search strategy using filters and a Boolean association strategy (MeSH term/Decs, Table 1). We included the Latin American and Caribbean Center on Health Sciences (LILACS, http://bases.bvs.br) and Medline databases (Table 1) in our study.

For the Medline search, we used an initial filter limiting publications to those published after 2004 because there was a high-quality comprehensive review published that year.[7]

The search for articles in the LILACS database was performed from the onset of its creation (1982). Using the articles identified using the initial search strategy, two independent researchers manually identified all articles that could be included in this study.

The inclusion criteria were as follows: epidemiological studies (cross-sectional, case-control, and cohort) and studies focused on non-recreational soccer players, including players under 17 years old, under 20 years old, and professionals. We excluded studies that focused exclusively on pediatric populations or included other sports in the analysis. In addition, we excluded studies that did not analyze musculoskeletal injuries. Studies by Hägglund[7] and Drövak[5] were used as the basis for this new model because they incorporated the relevant studies published prior to 2004. The titles and structured abstracts of studies were used to identify relevant articles. When the titles and abstracts provided insufficient information to determine inclusion or exclusion, the articles were read in full. When the two evaluators could not reach consensus regarding the inclusion of a particular article, a third evaluator assisted with the decision.

A complete reading of all selected articles and the subsequent analysis of each study's primary findings (Tables 2, 3) was performed to reach a consensus. To promote this consensus of the Brazilian Football Association (CBF), the researchers met during the preparation of the final document.

## RESULTS

We considered 60 studies from Medline and 16 studies from LILACS in the final analysis. Twelve studies were selected for final inclusion in this review: seven from LILACS[4-10] and five from Medline.[11-15] The characteristics of each study are provided in Tables 2, 3, and 4. Prospective cohort studies were the most common studies (58%), followed by cross-sectional studies (25%) and retrospective studies (17%) (Tables 2, 3, and 4).

## DISCUSSION

Epidemiological studies on professional soccer player injuries should be conducted prospectively based on a hierarchy of evidence. The prospective cohort design is more efficient than retrospective, cross-sectional, and case control studies. The retrospective study design, which was once widely used, has many biases that can reduce the validity of risk assessments. Therefore, the selection of a prospective design ensures that the measurement of injury risk is more reliable.[16]

To evaluate the risk of injury for a particular sport, one must consider the time of athlete's exposure to sports activities, i.e., measure how long an individual athlete is exposed to the injury risk. The standard measure for reporting the incidence of soccer injuries is usually the number of injuries per 1000 hours of sports participation.[17] Exposure assessments should be determined individually, as individual athletes will have different degrees of exposure due to varying training and playing time, even among players on the same team. Exposure time is the total number of hours of exposure for each individual, including the time spent training and the time played in games from the start of the monitoring period (usually the beginning of the season) until the first injury occurs or until the end of the monitoring period (if no injury occurs).[7] Once a player recovers from an injury and resumes full participation in training and in games, the exposure time starts again.

The study period must include at least one full season, including the preseason. Hagllund et al.[11] demonstrated that the incidence of injuries was similar in two consecutive seasons, indicating that a study covering one full season can provide a sufficient overview of the incidence of injuries among elite soccer players. However, a prolonged study period is recommended for the analysis of specific patterns of injury.

**Table 1 -** Search Strategy.

| | Terms |
|---|---|
| #1 | ''Athletic Injuries''[Mesh] |
| #2 | Soccer"[Mesh] |
| #3 | random*[tiab] OR cohort*[tiab] OR risk*[tiab] OR causa*[tiab] OR predispose*[tiab] OR odds ratio[mh] OR case control* OR odds ratio* OR controlled clinical trial [pt] OR randomized controlled trial [pt] OR risk[mh] OR practice guideline[pt] OR epidemiologic studies[mh] OR case control studies[mh] OR cohort studies[mh] OR age factors[mh] OR comorbidity[mh] OR epidemiologic factors[mh] |
| #4 | #1 AND #2 AND #3 AND #4 |

**Table 2 -** Characteristics of the studies selected for final inclusion.

| | Type | N | Period | Contact person | Manual | Injury/1000 h | Age | Exposure factor | National/Reserve |
|---|---|---|---|---|---|---|---|---|---|
| Hagglund et al; 2006 | P | 263 | 2 seasons | Y | N | NA | 17-39 | I | Y |
| Azubuike & Okojie; 2009 | T | 196 | 1 season | NA | N | NA | NA | I | NA |
| Waldén et al; 2005 | P | 266 | 1 season | Y | Y | 9.4 | NA | I | Y |
| Paus et al; 2003 | P | 376 | 2 seasons | Y | N | 1.42 | 16-19 | I | NA |
| Paus et al; 2003 | P | 86 | 7 seasons | Y | N | 9.1 | 17-37 | I | NA |
| Cohen et al; 1997 | R | 200 | 3 seasons | Y | N | NA | 16-40 | I | NA |
| Kucera et al; 2005 | P | ND | 3 seasons | NA | N | NA | 16-19 | NI | NA |
| Selistre et al; 2009 | T | ND | 6 days | Y | N | 128.1 | 16-20 | I | NA |
| Palacio et al; 2009 | P | 30 | 2 seasons | N | N | NA | 18-35 | I | NA |
| Yoon et al; 2004 | T | 411 | 2 seasons | Y | N | 141.8 | average 22 | I | Y |
| Martinez & Villani 2003 | R | 656 | 7.4 seasons | NA | N | NA | <20 | I | Y |
| Ladeira 1999 | P | 62 | 6 months | NA | N | 13.4 | average 24.8 | I | NA |

P – Prospective.
T – Transversal.
R – Retrospective.
N - Number of individuals.
Y – Yes.
N – No.
NA - Non available.
h - hours of exposure.
I – Individual.
NI - Non individual.

The start of data collection for the study requires that a questionnaire must be submitted by each athlete prior to the start of the season. This questionnaire should include the height, weight, body mass index (BMI), position, age, years of professional experience, dominant leg, history of previous injuries, number of games played during the previous season, and previous surgical history of each player. Other information, including flexibility, goniometry, lower limb proprioception, and podoscopic examinations can be added to the questionnaire.

It is important to evaluate the flexibility of the quadriceps and hamstring muscles during the preseason to identify soccer players with a high risk of developing muscle injuries during the regular season.[18] The flexibility of these muscles can be goniometrically measured bilaterally because previous studies have shown good validity and reliability with this method.[21,22]

Appraising proprioception in the lower limbs is also important because a previous study revealed differences in the dislocation of the center of gravity and changes in postural balance in soccer players who had undergone ACL reconstruction.[19]

The history of previous injuries reported by the player should be divided as follows: no previous injuries, a single report of a previous injury, and a history of two or more previous injuries.[15] At this moment, athletes should be asked to provide written informed consent.

Each athlete's exposure to injury must be individually recorded either weekly or every two weeks and should cover all training and games. It can be helpful to use a table with the name or code of each player and his or her exposure time (in minutes) for games and practices. Other information, such as the field surface, the temperature and weather conditions during the game, the amount of time spent traveling, the type of training performed, and the game site (home or visitor), should be included in the record.

Travel by athletes will be ranked according to the distance traveled in kilometers (km) on the outward journey from the club's city to the city where the game will be held. Trips will be classified into one of three categories based on distance as follows: short distance (<500 km), medium distance (between 500 and 800 km), and long distance (>800 km). These distances will be calculated using the method that was used for the Series A 2010 Brazilian Championship, calculating the total distance that the athletes traveled to the games during the tournament. This distance was divided by the total number of trips, and the average distance was 818 km for the outward journey. We used this number as the basis for the above classification for travel within the large Brazilian territory.

We will also calculate the travel time (in minutes) for players. Travel time is defined as the number of minutes spent by each player traveling between their home club and the hotel in the city of the game added to the time spent on their return trip. If athletes do not return to their home club but travel to another city for a game, the travel time will be computed as the time required to travel from one hotel to the next. Travel is divided by distance and time, because clubs utilize different means of transportation due to financial circumstances and preferences.

Injuries should be recorded by the date of injury, injury type, location and severity, and setting of injury occurrence (i.e., a training session or game). The injury protocol may contain a field with the required exams and final diagnosis.

More information can be included in this record, including weather conditions at the time of injury, the surface, the injury mechanism, the time at which the injury occurred, the field location where the injury occurred, and whether the referee called a penalty on the play in which the injury occurred (if the injury was due to contact with another player). One study reported that referees recognized infractions in only 47% of cases.[20]

Recording the playing time when the injury occurred during the game is important because the highest injury risk was found to occur during the first and last 15 minutes of the game.[21]

## Ethics

All study participants signed an informed consent document, and an Ethics Committee reviewed and approved the study.

**Table 3 -** Characteristics of the studies selected for final inclusion.

| | Injury definition | Reinjury | Rehabilitation | Injury severity (days) |
|---|---|---|---|---|
| Hagglund et al; 2006 | Time loss | Similar injury after return | complete return (practice and games) | Mild (1-3)/Minor (4-7)/Moderate (8-28)/Major (>28) |
| Azubuike & Okojie; 2009 | Time loss | NA | NA | Mild (1-3)/Minor (4-7)/Moderate (8-28)/Major (>28) |
| Waldén et al; 2005 | Time loss | Similar injury until 2 months | complete return (practice and games) | Mild (1-3)/Minor (4-7)/Moderate (8-28)/Major (>28) |
| Paus et al; 2003 | Injury during game or practice which withdraw the player | NA | NA | Mild (1-7)/Moderate (8-21)/Severe (>21) |
| Paus et al; 2003 | Injury during game or practice which withdraw the player | NA | complete return (practice and games) | Mild (1-7)/Moderate (8-21)/Severe (>21)/Most severe (>56) |
| Cohen et al; 1997 | NA | NA | NA | Mild (0-7)/Moderate (8-30)/Severe (>30) |
| Kucera et al; 2005 | NA | NA | NA | NA |
| Selistre et al; 2009 | Event which lead to loss ≥1 game | NA | NA | NA |
| Palacio et al; 2009 | Withdrawal ≥10 days | NA | NA | NA |
| Yoon et al; 2004 | Absence in practice or game | NA | NA | 1 (0)/2 (1-3)/3 (4-7)/4 (7-30)/5 (>30) |
| Martinez & Villani 2003 | Injury confirmed by doctor and absence ≥2 days | NA | NA | NA |
| Ladeira 1999 | Injury which prevent the return at the same or following days | Similar injury less than 8 weeks | NA | Mild (1-7)/Moderate (8-28)/Severe (>28) |

NA - Non available.

## Study Manual

One major concern is how to collect reliable data. One should prepare a study manual to instruct club leaders on proper data collection and recording techniques. This manual should be distributed to participating clubs before the start of the study to prevent any inappropriate collection of data and standardize the definitions used in the study. This manual should include fictitious cases and examples to guide the club leaders.[7]

## Contact Person

Professionals should be selected for collecting and recording data before the study begins. The selection of these individuals is extremely important for accuracy, as any changes in the collection method may alter the outcome and comparisons between studies. The person selected must be present at all trainings and games and is often a member of the team's medical staff.

All athletes from the first team should be included in the study. Even athletes with a history of previous injuries should be included because excluding these individuals could lead to bias in the study. An athlete injured at the beginning of the study should not be excluded from the study, but their injury should not be recorded; instead, the athletes' exposure time will only begin when he or she is fully recovered from injury.

Injuries that occur outside the training sessions and games must be separately recorded. For instance, injuries occurring during breaks or while practicing other sports should not be grouped with injuries that occur during training sessions and games. This is critical as the purpose of this study is to assess the risk of soccer-related injuries.

Injuries occurring during training and games involving the national team should be registered.[22] Injuries occurring during training games against the reserve team or other teams should be considered because the game in question is not part of the rehabilitation of an athlete with a previous injury.[7]

To allow comparisons between different studies, it is extremely important to define injuries in a uniform manner. Various definitions of injury have been used in previous studies. Most of these studies use the definition of withdrawal time (''time loss''). This definition emphasizes

**Table 4 -** Inclusion and exclusion criteria.

| | Inclusion/Exclusion criteria |
|---|---|
| Hagglund et al; 2006 | All players of the professional team |
| Azubuike & Okojie; 2009 | All players registred in the team |
| Waldén et al; 2005 | All players of the professional team |
| Paus et al; 2003 | NA |
| Paus et al; 2003 | All players of the professional team |
| Cohen et al; 1997 | All players of the professional team |
| Kucera et al; 2005 | NA |
| Selistre et al; 2009 | Amateur players between 16-20 years |
| Palacio et al; 2009 | Injuried players withdrawn ≥10 dias |
| Yoon et al; 2004 | All players at 2000 Asia Cup and 2000 under 19 asiatic juvenile tournament |
| Martinez & Villani 2003 | Under 15/17/20 Argentina national players da Seleção Argentina between 1994 and 2002 |
| Ladeira 1999 | Canadian amateur players/Excluded if withdrawn from pratice or game >8 weeks or previous injury |

NA - Non available.

the importance of athletes who do not pursue activities resulting from their injuries. Other definitions of injury have been used, such as the need for medical treatment due to injury (''medical assistance'') or the registration of all injuries regardless of whether or not the injury prevented the player from continuing to training or playing in the game (''tissue injury'').

The definition of injury varies widely in the literature. However, we will use the classical definition presented by J. Dvorak and A. Junge: injuries are defined as events that occur during training or a game that cause an athlete's absence from the next training session or game and are followed by the necessity for an anatomic diagnosis and treatment of the injured tissue.[23] It is appropriate to include injuries that cause the interruption of training or playing in a game, regardless of whether the player is absent from the next game or training session. This is especially important for less competitive teams where games and training sessions occur less frequently. These injuries can be separately recorded as zero day injuries.

In the time loss system, injury severity is classified according to the number of days that the player is absent. This number varies widely in the literature. Our model uses the following classification for injuries: mild (1-3 days), minor (4-7 days), moderate (8-28 days), major (>28 days and <8 weeks absence), and severe (≥8 weeks off). This classification system was divided into five types so that we can group together the various soccer injuries into more homogeneous groups that exhibit similarities in severity and prognosis. We disagree with the classification that divides the severity of injury into three types,[3] because grade III (>28 days absence) covers a wide range of injuries that greatly differ in terms of their severity and recovery time. This three-step classification system groups together relatively benign cases such as muscle injury, where the recovery time varies from 4-6 weeks, and other more serious injuries, where the recovery time can average 6-8 months for an anterior cruciate ligament injury.[8]

The precise definition of various injury types is required to compare between studies conducted worldwide. Usually the injuries are divided into two major groups: trauma and overuse. Van Mechelen[24] suggested that an injury be defined as acute if it is caused by a single traumatic incident and as overuse if it is the consequence of repetitive microtraumas. The national model divides injuries into eight categories, which are provided in Table 5.

We defined injury recurrence as instances in which an injury of the same type and in the same location as the initial injury occurs within two months of the final day of the initial injury. This relates to rehabilitation for injuries prior to the start of the study and within 12 months for injuries occurring during the study period. The choice of the two-month period for injuries prior to the start of the study was an attempt to reduce the bias of injuries that have occurred well before the current athlete monitoring. We believe that defining recurrent injuries as any injury sustained previously would contribute bias to the study. Nevertheless, for injuries occurring during the study period during which we have detailed information, we stipulate the maximum time period to be 12 months for recurrence. We divide the recurrence of injuries into two groups: early recurrence (<2 months) and late recurrence (between 2 and 12 months).[25]

Another parameter to consider in the classification of re-injury is the number of games and/or training sessions performed between the initial injury and the re-injury. This is important because the frequency of training sessions and games are different among soccer clubs. Therefore, we classify early re-injuries as those occurring within 15 games and/or 60 training sessions and late re-injury as those that occur after≥15 games and/or 60 training sessions. We performed this classification using the average frequency of games and training of Brazilian clubs (two games and eight training sessions per week). Therefore, 15 games or 60 training sessions are conducted over a period of approximately two months.[4]

A training session is considered to be any physical activity performed by the team that is directed by the coach. Therefore, a pool recovery session or a gymnastics session held after a game should be considered training. A video review or a lecture with the team should not be considered training. Individual training sessions should not be registered.[26]

An athlete presenting with an injury in the final game of the season who is still injured at the end of the study should, if possible, be accompanied by the researcher on the final day of their rehabilitation. If this is not possible, the researcher should estimate and record the probable time required for a complete recovery.

If a player transfers or retires, the researchers must include the exposure time and injury until the date of transfer or retirement. If the athlete is injured at the time of transfer, the recovery of that athlete should be monitored, if possible, until a full recovery has occurred.

Athletes who join a club during the season should not be included in this study. However, new players that are added to the roster during the pre-season should be included.

## CONCLUSION

This study establishes a methodological model that can be applied to epidemiological studies of injuries to professional

**Table 5 -** Classification of injury types.

| ***Traumatic*** |
|---|
| Sprain Acute wrenching or laceration of the ligaments or capsule of a joint |
| Strain Acute distraction injury of muscles and tendons |
| Contusion Injury that does not disrupt the integrity of the skin caused by a blow to the body |
| Fracture Traumatic break or rupture of bone |
| Wound Injury that breaks the skin, including cuts, scratches and puncture wounds |
| Dislocation Forced separation and misalignment of bones in a joint cavity |
| Other Injuries not classified elsewhere |
| ***Overuse*** |
| A pain syndrome of the musculoskeletal system with insidious onset and without any known trauma or disease which may have yielded previous symptoms |

soccer players. Creating and establishing this national model is extremely important to Brazil and other large tropical countries as the characteristics of soccer and the geographical dimensions are quite different from those of Europe and the rest of world.

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